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green band of the spectrum given by a vacuum tube containing alcohol.

| Greenwich Sidereal Time. | Comet-band—Alcohol band | | Inferred Wave-length of Comet band. |
|---|---|---|---|
| | Micrometer Reading | Wave-length tenth-metres | |
| h m | r | | |
| 0 30 | 1·885 | 34·5 | 5162·5 |
| 0 45 | 2·269 | 41·5 | 5155·5 |
| 1 5 | 2·176 | 39·8 | 5157·2 |
| 1 20 | 1·980 | 36·2 | 5160·8 |
| 1 40 | 1·708 | 31·3 | 5165·7 |
| | | Mean | 5160·3 |

The green band of the comet spectrum was obviously not coincident with the green band of the alcohol spectrum, but far to the blue of it. There was, however, a bright line in the spectrum from the alcohol vacuum tube coincident with the green band of the Bunsen-flame, and with this the comet-band was very nearly coincident. It seemed, however, a little to the blue of it. The width of the slit during the above measures was 15·8 tenth-metres.

Thalén's wave-length for the less refrangible edge of the green band in the spectrum of the alcohol was assumed throughout: viz. 5197·0 tenth-metres.

*Royal Observatory, Greenwich :*
1883, *Dec.* 13.

## *Rotation Period of Jupiter.* By W. F. Denning.

Observations of the last few years have proved that one rotation period will not satisfy the motion of different markings on the surface of *Jupiter*. Nor will one period satisfy the same marking for a lengthened interval, as the individual spots have in certain prominent cases shown a slackening motion, the amount of which increases with the time.

At Bristol since 1880, September 27, the great red spot has been observed as it crossed the planet's central meridian on 152 nights. The equatorial white spot has been similarly recorded on 150 nights. Other markings of apparently less permanent character have been carefully watched for shorter intervals. I have partly derived the longitudes of the red and white spots and otherwise reduced the observations by the aid of Mr. Marth's valuable Ephemerides published in the annual volumes of the *Monthly Notices*.

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As to the red spot, the following observations have been obtained during the present apparition:—

| | On C. M. | Longitude. |
|---|---|---|
| | h m | ° |
| 1883, Aug. 23 | 16 48 | 67·3 |
| Oct. 15 | 15 37 | 71·7 |
| 17 | 17 14 | 71·1 |
| 20 | 14 44 | 71·6 |
| Nov. 3 | 16 17 | 73·8 |
| 18 | 13 34 | 72·1 |
| 19 | 19 25 | 74·8 |
| 25 | 14 25 | 76·3 |
| 29 | 17 38 | 75·0 |
| Dec. 4 | 16 48 | 77·4 |
| 5 | 12 41 | 78·6 |

The observed times of the passages across the central meridian of *Jupiter* are in every case estimated. This method, though undoubtedly less accurate than direct measurement, is found to be very reliable, for the apparent motion of an object near the central meridian is so great that an interval of $3^m$ is sufficient to introduce a change of place obvious to the eye. It is believed therefore, that in all the observations where the conditions of seeing have been favourable the average error is less than $2^m$. The longitudes have been computed from the daily rate of $870^\circ{\cdot}42 =$ rotation of $9^h\ 55^m\ 34^s{\cdot}47$, which Mr. Marth has adopted for his recent Ephemerides.

The spot shows a very decided increase in its rotation period. My results for the last few oppositions are as follow:—

| Interval. | Number of Rotations. | Period of Rotation. |
|---|---|---|
| | | h m s |
| 1880, Sept. 27–1881, Mar. 17 | 413 | 9 55 35·6 |
| 1881, July 8–1882, Mar. 30 | 640 | 9 55 38·2 |
| 1882, July 29–1883, May 4 | 674 | 9 55 39·1 |
| 1883, Aug. 23–1883, Dec. 5 | 251 | 9 55 38·8 |

Comparing my observation on 1883, December 5, $12^h\ 41^m$, with an observation made by Mr. Trouvelot at Cambridge, Mass., on 1878 September 25, $6^h 55^m$, Cambridge mean time, I find that the average rotation period of the spot has been

h m
9 55 36·2

during the 1897 days (=4586 rotations) embraced by the observations.

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Professor Hough gives the period as $9^h\ 55^m\ 35^s\cdot9$ for the interval 1879, September 25–1882, March 29, comprising 916 days (2214 rotations). He notes that in 1879 the period was $9^h\ 55^m\ 34^s\cdot0$, while during the last opposition it had increased to $9^h\ 55^m\ 38^s\cdot4$. These results are in very good accordance with those obtained at Bristol.

At the present time the spot follows the assumed first meridian of *Jupiter* (*Monthly Notices*, June 1883) by about $2^h\ 10^m$, and the interval is increasing at the rate of $4^m$ per month.

During the opposition of 1882–3 the spot became extremely faint, so that when the planet left us in May 1883 it was felt that, should the spot continue to fade, it must cease to be visible by the time *Jupiter* reappeared from conjunction at the end of August. But the spot was re-detected by Mr. A. S. Williams at Brighton, and by myself at Bristol, on the morning of August 24, and since then has been distinguished by several other observers, though Signor Ricco, of the Palermo Observatory, failed to find any traces of the spot on the mornings of September 11, 14, and 21, and announced its disappearance.* With the 10-inch Refractor of that Observatory the region of the disk formerly occupied by the spot appeared very white. Mr. Williams, however, saw the spot well as it came to the central meridian of *Jupiter* on September 14 and 16, and during the ensuing months of October and November it has been very plainly visible. On December 4, as it crossed the central meridian, I saw it with great distinctness and definiteness of outline, and conclude that it is certainly as plain now as it was nine months ago. The fact that it has become more prominently visible during the last few weeks is explained by the more favourable position of *Jupiter*, and not by any actual deepening of tint in the spot itself.

It is altogether open to conjecture whether this marking is identical with certain large and definite spots which have been observed in former times, and exhibited a nearly similar period of rotation. The spots seen by Hooke and Cassini in 1664 and subsequent years cannot be held to have any certain relation to the one now visible, as there is an absence of intermediate evidence to serve as a connecting link. The old observations unmistakably refer to an object in nearly the same position as the spot of our own time, but the former must have been considerably less in magnitude, it being estimated as only one-tenth the diameter of *Jupiter*, whereas the present red spot is about one-third; in fact the latter is fully three times the size of the former.

But though it seems impossible to trace a distinct association with markings which appeared at such a remote period, we may perhaps discern a more satisfactory analogy with some modern observations. We may feel assured, however, that in the time of Lassell and Dawes there was no large and permanent spot on the

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* Sig. Ricco writing to *L'Astronomie* for Dec. 1883, states that he succeeded in re-detecting the spot on Sept. 28.

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surface of *Jupiter*. Had such a phenomenon presented itself it must have awakened a keen interest in observers eager to avail themselves of the investigation which such an important apparition must invite. But in 1869 and 1870 an object was discovered by Mr. Gledhill, which from its position, motion, and aspect appears to have been the precursor of the red spot. It was first seen on November 14, 1869, and "carefully observed until March 1870, but in July of the same year it disappeared," though on December 1, 1871, a similar object was observed apparently resting on the southern margin of the equatorial dark belt. The marking seen by Mr. Gledhill was in the form of a dark elliptical ring, its major axis lying parallel with the belts. It was darkest at the E. end, and appears to have occupied the same latitude as the red spot. On January 23, 1870, and other occasions, a narrow belt was noticed immediately outlying the great S. belt, and bent abruptly to the N. just under the following end of the ellipse. This is precisely what has been observed in regard to a small belt following the red spot in 1880 and 1881, and the fact of the dark E. extremity of the ellipse offers additional corroboration to the theory of its identity with the red spot, for the latter during the time I have observed it has always shown a very dark minute spot at its E. end. Moreover, the rotation period of the ellipse during the winter months of 1869–70 was about $9^h 55^m 33^s$, which nearly agrees with that of the red spot.

Should this ellipse have developed into the red spot, it is curious what became of it during the years from 1871 to 1878. Mr. Corder in March and April 1872 saw a large elliptical spot in the S. hemisphere of the planet, and Lord Rosse in the following year observed a similar object. In 1876 Mr. Russell at Sydney also mentions having seen the spot, though during the opposition of that year no corroboration is met with amongst the results of other observers.

If the ellipse of 1869–70 was really the forerunner of the red spot, the period of rotation has increased but little during the intervening ten years, and the slackening motion which has become so well defined since 1880 cannot previously have affected the spot to any great extent, unless there is an oscillatory motion of long period, which seems quite possible. In connection with this question it is interesting to note that the increasing retardation of the red spot as observed chiefly in 1881 and 1882 seems now to have become less decided. My own observations show an increase of 2·6 sec. in the rotation period, ascertained during the successive apparitions of 1880–81 and 1881–82, whereas the increase in 1882–3 over 1881–82 was only 0·9 sec. And the observations so far as they have progressed during the present apparition prove that the period has decreased 0·3 sec. as compared with the results of the previous apparition. The question naturally arises, therefore, as to whether the spot has now commenced to drift in W. longitude? If so, we shall soon realise its effects in the shortening of the rotation period. The

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observations of the last few months are very suggestive in this respect.

The equatorial white spot has continued well visible during the present year, though on the whole I believe it is scarcely so brilliant as in the autumnal months of 1880. From a large number of observations obtained here since 1882 I have selected about one per month to exhibit the increasing longitude of the spot relatively to the daily rate of 878°·46=rotation of $9^h\ 50^m\ 7^s{\cdot}42$, which Mr. Marth found conformable to the observations of 1880 Oct.–1882 Aug.:—

| | On C. M. | Longitude. |
|---|---|---|
| | h m | ° |
| 1882, July 29 | 15 49 | 29·8 |
| Aug. 23 | 15 51 | 29·9 |
| Sept. 27 | 11 52 | 28·9 |
| Oct. 25 | 18 32 | 31·0 |
| Nov. 26 | 17 37 | 31·7 |
| Dec. 23 | 8 51 | 32·9 |
| 1883, Jan. 23 | 12 33 | 42·6 |
| Feb. 23 | 6 13 | 41·5 |
| Mar. 24 | 8 45 | 45·1 |
| May 4 | 8 32 | 45·0 |
| Aug. 24 | 16 35 | 62·8 |
| Oct. 15 | 17 56 | 67·3 |
| Nov. 3 | 14 17 | 64·3 |
| 25 | 17 25 | 66·2 |

It is evident by the marked increase of longitude, which the table shows, that this white spot moves considerably slower than during the earlier observations. For the purpose of tracing the extent of this retarded velocity, I have arranged my observations into three periods, with the following result:—

| Interval. | Number of Rotations. | Period of Rotation. |
|---|---|---|
| | | h m s |
| 1880, Oct. 20–1881, Sept. 30 | 842 | 9 50 5·8 |
| 1881, Sept. 30–1882, Dec. 23 | 1095 | 9 50 8·8 |
| 1882, Dec. 23–1883, Nov. 25 | 823 | 9 50 11·4 |

The rate of increase in the rotation period during the three years included in the observations has been nearly six seconds, which is greater than the retardation in the motion of the red spot. The mean period of the white spot from the whole interval of my observations is

$$9^h\ 50^m\ 8^s{\cdot}7,$$

which comprises 1131 days (=2760 rotations).

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The conjunctions of the two spots are extremely interesting, because at such a time their great differences of velocity are strikingly manifested. In the *Monthly Notices* for Jan. 1882 I gave the interval of these conjunctions as 44$^{d}$ 10$^{h}$ 42$^{m}$, and from the observations which have accumulated since that time this period is proved to be not very far from the truth. On Nov. 25, at 17$^{h}$ 25$^{m}$ the white spot followed the red spot by 3$^{h}$, and on Dec. 19 at 12$^{h}$ 3$^{m}$, the white spot preceded it by 2$^{h}$ 6$^{m}$, so that allowing for the diurnal gain of 13$^{m}$ 24$^{s}$ by the white spot, the conjunction must have occurred (from a mean of the two observations) on Dec. 9 at about 15$^{h}$. This compared with an observation on Nov. 19, 1880, at 9$^{h}$ 23$^{m}$, when the two markings occupied exactly the same longitude, gives the average period from 25 conjunctions which have occurred in the interim of 1115$^{d}$ 5$^{h}$ 37$^{m}$ as

$$\overset{d}{44}\ \overset{h}{14}\ \overset{m}{37{\cdot}5}.$$

Should the two spots remain visible, they may be observed near conjunction at the following times:—

| 1884. | h m | 1885. | h m |
|---|---|---|---|
| Jan. 23 | 5 37·5 | Jan. 15 | 2 37·5 |
| Mar. 7 | 20 | Feb. 28 | 17 15 |
| Apr. 21 | 10 52·5 | Apr. 13 | 7 52·5 |
| June 5 | 1 30 | May 27 | 22 30 |
| July 19 | 16 7·5 | July 11 | 13 7·5 |
| Sept. 2 | 6 45 | Aug. 25 | 3 45 |
| Oct. 16 | 21 22·5 | Oct. 8 | 18 22·5 |
| Nov. 30 | 12 0 | Nov. 22 | 9 0 |

The motion of the white spot is affected by some curious variations. Even in a few nights it occasionally shows a considerable displacement, so that the resulting longitudes vary in the most striking and apparently irregular manner. Referring to the table of longitudes on the previous page, we shall find that it increased nearly 10° during the month preceding 1883 Jan. 23, and that during the interval from 1883 May 4 to Aug. 24 the increase was nearly 18°.* But during the last few observations, up to 1883 Nov. 25, the velocity of the spot appears to have been more consistent. These singular displacements of position show irregularities both in extent and period, and have been well corroborated by other observers. Thus Prof. Hough ("Report of Dearborn Observatory, 1882," p. 50, remarks, "During 1881 the spot, observed continuously for a period of 252 days, in-

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* This displacement of 18° is equivalent to more than 13,000 miles on the surface of *Jupiter*.

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dicated sudden deviations in its apparent place, probably due to change of shape in the object observed." On Oct. 8, 1881, he noted "a maximum displacement of 16 minutes of time, or more than 3″ of arc at mean distance."

There are two other bright objects near the principal white spot, and it has sometimes occurred to me that the rapid displacements in its position may result from the alternate visibility of these several objects. While the chief spot is near its minimum, one of the bordering spots may assume greater prominence, and the observer will thus be easily misled. This explanation offers a satisfactory solution to the phenomena observed; but though I have critically watched the behaviour of these objects I could never be certain that this supplied the real cause of the difficulty. Could their relative appearances be noted nearly every night for a few weeks the point might doubtless be settled.

Apart from its vagaries of motion, the white spot changes its visible aspect very materially. It is sometimes extremely large and brilliant, shining with almost startling effect on the equatorial border of the great southern dark belt. At other times it is very small and faint, and only perceptible after close examination. On four different occasions I have absolutely failed to detect any vestige of the spot, though the central part of the disk was thoroughly examined at the time of its passage.

The spot also varies in form as well as in brightness. It is usually in the shape of a brilliant oval, well defined, and occasionally quite as large as the third satellite of *Jupiter*; but it is sometimes seen as a diffused white patch apparently emerging from the N. edge of the belt. Whenever the spot is bright and well defined there is a trail of light, or diffused luminous matter, running from its east side as though there were an eruption of luculent material from the spot which the rapid rotation of the planet from W. to E. caused to drift in an opposite direction.

The cause of the obscurations * to which the spot is subject would be easily explained on the supposition that the dark spots and patches which abound along the equatorial zone move with a different velocity, and temporarily overlap it. But from careful observation of the equatorial markings it is proved that their

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* I may adduce as an example of these variations of light, some observations obtained here in Dec. 1882 and Jan. 1883. On Dec. 22 and 23 the spot was recorded as very brilliant, but on Jan. 1 it had become so far reduced as to be utterly invisible in my 10-inch Reflector. On Jan. 3 I re-detected it, but it was very faint. On Jan. 9 the spot was described as bright, and on the 13th had arrived at a maximum, so as to present a very conspicuous appearance on the disk of the planet. But a far more surprising change was noticed in regard to a small white spot immediately preceding the chief spot (by about 9 ) in Nov. 1880. On the 17th, at $7^h$ $56^m$ this object was described as small and bright as it passed the C. M., but on the 19th it was quite obliterated. A few days later, I received a letter from Mr. F. C. Dennett of Southampton, in which he referred to the same thing, so that in this case we have a well-corroborated instance of rapid change.

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velocity is identical with that of the white spot. They are seen to maintain the same relative distances, so that, whatever the cause of the obscurations in the white spot, it is certainly not due, as was formerly supposed, to the interposition of the dark spots in the same latitude. We are thus led to the inevitable conclusion that the variations of brightness are attributable to some inherent phenomena resulting from the peculiar constitution and condition of the spot itself. The appearances would indicate a volcanic nature, and its frequent increase and decrease of brilliancy would seemingly be the index to its alternating periods of activity and quiescence. In any case, it is probable the spot shines with intrinsic light, and it would be an important feature in connection with the progress of these inquiries to witness the transit of a satellite-shadow across it. The projection of such a shadow cone upon the spot might not obliterate it entirely, whence we should infer that its excessive lustre must be due to some other agency than reflection.

The lengthening period is quite opposed to any thesis which attributes to the spot a permanent situation on *Jupiter.* It must in some sense be atmospheric, for whatever it may be, and whatever conditions affect its existence, it cannot be an integral part of the planet, but is more probably a mass or volume of matter quite detached, though formerly evolved, from the surface. The fact that it moves with much greater velocity than the red spot leads us to the inference that, while the latter is on the extreme outer envelopes of the planet, the white spot is amid the lower strata, and rendered conspicuously visible by the convulsions which it is evident are of frequent occurrence on the equator. And one of the most remarkable features of this object is its long duration in a region where many changes are apparently operating to oppose its persistency. We have evidence of this in the different aspect which the spot assumes at short intervals, and in the oscillatory movement to which it is commonly subject.

There can be little question that this particular marking existed for some years before it came under general observation in the autumn of 1880, for the records and drawings of the few preceding oppositions contain obvious reference to an object of precisely similar character and position. Thus Prof. Hough's results at the Dearborn Observatory in 1879 include figures of *Jupiter* on Sept. 20, $9^h\ 45^m$, and Oct. 15, $8^h\ 7^m$, Chicago mean times. In the former of these delineations the white spot is well shown on the extreme west limb of the planet, and in the latter it is seen very slightly in advance of the middle of the red spot, so that a conjunction of the two markings must have occurred a few hours previously. Now, computing back on the period of $44^d\ 14^h\ 37^m\!\cdot\!5$ we shall find that the present white spot would be in conjunction with the red spot on 1879, Oct 15; hence the absolute identity of the object seen on that date by Prof. Hough with the one now visible appears to be beyond question.

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It was not so regarded by him* however, on account of a marked increase of rotation period which must have taken place during the oppositions of 1879, 1880, and 1881, and moreover between the epoch of 1880 Oct. 1 and Oct. 28, the spot, if the same, must have suffered a great retardation, as it came to the central meridian fully 30 minutes after its computed time. This represents an increase of longitude of about 18° in 27 days, which is rather startling if we admit its actual occurrence. But in view of the "sudden deviations in its apparent place," which Prof. Hough and others have frequently observed, we may well consider it probable that the objects seen by him in 1879 and 1880 were identical with that now visible. In corroboration of this idea we have the conspicuous appearance of the spot detected by him in the earlier months of the series, and the fact that it is the only one depicted in his sketches. Besides, the position of his spot of 1879 indenting the great S. dark belt is exactly the same as that of the spot of 1880, which, from its brilliant appearance and obtrusive position with regard to this belt, could hardly fail to arrest the common attention of observers.

The rotation periods of the equatorial white spots observed by Prof. Hough were as follows :—

| Interval. | Period of Rotation. | | |
|---|---|---|---|
| | h | m | s |
| 1879, Sept. 10–1880, July 8 | 9 | 50 | 3·5 |
| 1880. July 8–1880, Oct. 1 | 9 | 50 | 0·5 |
| 1880, Oct. 28–1881, Jan. 30 | 9 | 50 | 9·8 |
| 1881, July 22–1882, Mar. 31 | 9 | 50 | 9·8 |

Prof. Hough would now, however, appear to regard several of these objects as identical, nothwithstanding the marked extension of period, for he says ("Report of Dearborn Observatory, 1883," p. 12), "The equatorial white spot which was first observed in 1879 was again visible during the past opposition [1882–3]. The rotation period as deduced last year, viz. $9^{h}\ 50^{m}\ 9^{s}\cdot8$ satisfies the observations."

The increasing period of the white spot (which Professor Hough's observations since 1880 October 28 do not corroborate), representing as it does a considerable retrograde movement on the planet, is very interesting, as the same phenomenon is well defined in regard to the red spot, proving that whatever the origin may be, it operates in both cases, and apparently in nearly similar degree according to my own observations. The further

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* He notes : "There are two principal spots, differing in longitude about 15° and in latitude about 1″." If, therefore, the spot observed by him for rotation in 1879 and 1880 is not absolutely the same as the one observed in later years, it must have had a much shorter period than at present, inasmuch as it preserved the same approximate difference in longitude from the similar spot which before 1880 Oct. 1 certainly indicated a period not greater than $9^{h}\ 50^{m}\ 3^{s}\cdot5$.

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investigation of the longitudinal drift in these markings and its rate of increase will be an important object of future investigation.

Though I have occasionally observed other spots upon the planet, and recorded their times of transit, they have generally been too evanescent to be followed long. A very curious discordance of periods has been exhibited, but they are none the less certain, and it may be useful to present some of the results in a tabular form to show the differences referred to. The various periods are corrected for equation of light, differences of Jovicentric longitude, and phase :—

| Ref. | Interval. | Number of Rotations. | Period of Rotation. |
|---|---|---|---|
| | | | h m s |
| *a* | 1878, Sept. 25–1883, Dec. 5 | 4586 | 9 55 36·2 |
| *b* | 1880, Oct. 31–1881, Jan. 16 | 186 | 9 55 17·9 |
| *c* | 1882, Oct. 30–1882, Nov. 26 | 66 | 9 51 47 |
| *d* | 1882, Nov. 1–1882, Nov. 26 | 61 | 9 50 17 |
| *e* | 1880, Oct. 20–1883, Nov. 25 | 2760 | 9 50 8·7 |
| *f* | 1880, Oct. 29–1881, Jan. 7 | 171 | 9 48 0·0 |
| | 1880, Oct. 29–1881, Jan. 8 | 174 | 9 47 58·2 |

*a.* The great red spot in the S. hemisphere.
*b.* A short dark belt or elliptical spot s.p. the red spot.
*c.* A bright spot slightly N. of the equator.
*d.* A dark patch on the equator.
*e.* The equatorial white spot (slightly S. of the equator).
*f.* Two dark spots on a belt about 25° N. of the equator. These objects moved with greater velocity than any other markings. Relatively to the red spot they completed a revolution around *Jupiter* in $32^d$ $10^h$. The rotation period of these spots seems to have been not only less than that of any other markings visible of late years, but also of any markings ever seen on the planet and observed for rotation.

From the above summary it is clear that the periods of different spots vary to the extent of $7^m$ $38^s$, and it is fair to conclude that these limits admit of considerable increase by further observation. Whether the shorter periods are more nearly representative than the longer ones of the true rotation-period of the planet's sphere must remain a matter of opinion in the absence of more definite evidence on the subject. It seems to me very probable that the real length of the Jovian day is even shorter than that of any period which has been hitherto indicated by the various atmospheric markings. It is more easy to admit that such markings have a tendency to fall into arrear of the great velocity of the globe of *Jupiter* than that objects of such permanency as the white spot have a direct motion of more than 250 miles per hour upon the planet. The behaviour of

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certain spots proves their disposition to lengthen out in longitudinal directions, and it is significant that this extension appears invariably to take place on the following side. The curious offshoot from the great S. dark belt which was seen in the autumn of 1880 N. of the f. end of the red spot developed into a very prominent belt by the constantly increasing prolongation of its E. end. And the dark patches near the equator generally run from the S. equatorial belt in an oblique direction to the E.; in fact all the visible markings seem to be more or less influenced by this tendency. The behaviour of these objects is evidently controlled by the rapid axial rotation of the planet from which they are evolved. And the true period of this rotation is at present unknown, but is probably much shorter than that usually adopted, though it may never admit of accurate determination, owing to the seemingly persistent obscuration of the planet's real surface.

*Bristol:* 1883, *Dec.* 24.

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## *On Humidity as a Cause of Variation in the Rate of Chronometers.*

### By Major-General J. F. Tennant, R.E., F.R.S.

(*Extract from a letter to the Secretary.*)

I recently sent a paper on the change of rate of a chronometer which was due to the humidity of the air. Posssibly this may be in time to be added as a postscript if the paper be printed in the *Notices.*

The change to dry weather has been accompanied by the corresponding change of rate, that from October 22 to November 1 having been $-3^{s}\cdot 41$ (losing). I have also heard from Mr. F. Chambers, at Bombay, who has examined the rates of sixty-three chronometers, and in five cases has found rates which are certainly independent of the temperatures, but which do appear to depend on the humidity. He finds (what my results show, though not conclusively) that the variation increases as time passes. If this be confirmed it is almost certain, I conceive, that the variation of rate is due to a gradual change in the oil.

*Calcutta:*
1883, *Nov.* 12.